

REMARKS

Applicants thank the Examiner for the courtesy extended to Applicants' attorney during the interview held August 4, 2006, in the above-identified application. During the interview, Applicants' attorney explained the presently-claimed invention and why it is patentable over the applied prior art, and discussed other issues raised in the Office Action. The discussion is summarized and expanded upon below.

The rejections of claims other than Claim 2 under 35 U.S.C. § 102(b) as anticipated by US 5,567,224 (Kundrat) or US 6,592,649 (Kikuchi et al), and under 35 U.S.C. § 102(b) as anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as obvious over, US 6,755,888 (Ibaraki et al) alone or in view of US 6,270,552 (Takeda et al), and under 35 U.S.C. § 103(a) as unpatentable over this prior art, are all respectfully traversed. All of the pending claims now contain the limitations of Claim 2, not subject to these rejections. Accordingly, it is respectfully requested that they be withdrawn.

The rejection of Claim 2 under 35 U.S.C. § 103(a) as unpatentable over Kundrat or Kikuchi et al or Ibaraki et al alone or in view of Takeda et al, and further in view of US 5,730,775 (Meissner et al) and *Perry's Chemical Engineers' Handbook* (Perry), is respectfully traversed.¹

As described in the specification under "Background Art," beginning at page 1, second paragraph, it is well-known in the art to reduce chromium oxide-iron oxide mixtures in the presence of a carbonaceous material. However, such reductions have been problematical for various reasons, including the fact that iron oxide undergoes reduction by carbon at a lower temperature, and thus earlier than corresponding reduction of chromium oxide, thereby leaving insufficient carbonaceous material to achieve a desired chromium

¹ During the above-referenced interview, the Examiner confirmed that the statutory ground stated in the Office Action, i.e., 35 U.S.C. § 102(b), was incorrect.

reduction degree. Increasing the amount of carbonaceous material to overcome this problem results in other problems.

Applicants address the above-discussed problem with the present invention. As recited in above-amended Claim 1, an embodiment of the present invention is a method for reducing a chromium-containing material, comprising a mixing step of mixing a chromium-containing material comprising chromium oxide and iron oxide and a carbonaceous reductant to provide a mixture; and a reducing step of heating, and reducing the mixture with a rapid temperature rise by radiation heating in a moving hearth furnace to provide a reduced mixture, wherein the average rate of raising the temperature of the mixture in the reducing step is 13.6°C/s or higher in the period from the initiation of the radiation heating of the mixture until the mixture reaches $1,114^{\circ}\text{C}$.

Applicants are thus able to increase the chromium reduction degree with the presently-recited rapid temperature rise by radiation heating, which is neither disclosed nor suggested by the prior art.

Kundrat, Kikuchi et al, Ibaraki et al and Takeda et al are all drawn to reducing metal oxides in rotary hearth furnaces using a carbonaceous material. However, and as Applicants' attorney pointed out during the above-referenced interview, none of these references discloses anything about the above-discussed problem, or Applicants' solution thereto which, as recited above, involves raising the temperature of the mixture in the reducing step at a particular minimum speed in the period from the initiation of the radiation heating of the mixture until the mixture reaches $1,114^{\circ}\text{C}$, which is the temperature at which the reduction of chromium oxide starts according to reaction formula (2), as described in the specification at page 14, first through third full paragraphs. Note further the definition of "initiation of the radiation heating" at the paragraph bridging pages 14 and 15 of the specification.

To cure the above-discussed deficiencies of the above-discussed prior art, the Examiner relies on Meissner et al and Perry. Meissner et al is drawn to a method and apparatus for producing direct reduced iron from dry compacts composed of iron oxide and carbonaceous material by feeding compacts no more than two layer deep onto a hearth and removing all the volatiles and metallizing the compacts by exposing the compacts to a radiant heat source at a temperature of from about 1316-1427°C for a total time period of about four to ten minutes and partially cooling the compacts while discharging them from the hearth (Abstract). Meissner et al discloses prior art in which such direct reduction was carried out at lower temperatures to dry and devolatilize pellets in order to avoid pellet exfoliation but that this method is disadvantageous in that it decreases productivity due to the long time required for pellets to reach optimum reduction temperature (column 1, lines 11-19). Meissner et al's discovery was that the pellets could be exposed immediately to a radiant heat source in the above-discussed temperature range without causing exfoliation and thereby obtain increased productivity (column 3, lines 18-33).

The Examiner relies on Perry for a finding that the rate of radiant heat transfer in a furnace is strongly affected by temperature.

The Examiner relies on Meissner et al to find that "the temperature of the radiant heat transfer source is a result effective variable which is varied to affect the time required to achieve metallization goals," and in view of Perry, therefore finds that it would have been obvious "to adjust the radiant heat source temperature as a result-effective variable in the process of Kundrat or Kikuchi et al or Ibaraki et al alone or in view of Takeda et al, therefore adjusting the rate of heating to affect the time required to achieve metallization goals as taught by Meissner et al."

In reply, and as Applicants' attorney noted during the above-referenced interview, the method and apparatus of Meissner et al has nothing to do with reduction of chromium-

containing materials and thus cannot possibly shed any light on the above-discussed problems which the present invention addresses. Moreover, the presently-recited rapid temperature rise limitation of the present claims is not simply rapid heating but rather raising the temperature at a particular minimum rate and for a particular period, ending at a particular end temperature, which coincides with the temperature at which the reduction of chromium oxide starts. Absent the present disclosure as a guide, there would have been no reason for one of ordinary skill in the art to combine Meissner et al and Perry with the remaining prior art, and if combined, the result would still not have been the presently-claimed invention.

In addition, for Claims 3 and 8, the specification herein contains data comparing reduction at 1,200°C, as shown in Fig. 3, and reduction at 1,300°C, as shown in Fig. 4, and as described for Example 1, beginning in the specification at page 24, second full paragraph. By comparing Figs. 3 and 4, it can be ascertained that for a particular residence time, the chromium reduction degree is significantly greater at the higher temperature but at a relatively constant Fe metallization degree. These results could not have been predicted by the applied prior art.

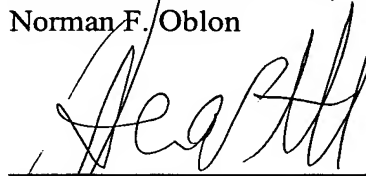
For all the above reasons, it is respectfully requested that the rejections over prior art be withdrawn.

Application No. 10/541,457
Reply to Office Action of June 23, 2006

Applicants respectfully submit that all of the presently-pending claims are now in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to pass this application to issue.

Respectfully submitted,

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